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MEMORANDUM FOR THE RECORD

SUBJECT : Preliminary Results from the April, 1983 Version of the Linked Policy Impact Model (LPIM)

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1. The revised energy sector of the LPIM has recently been joined to the revised macro sector. Some accounting problems and some TROLL blocking problems remain, but these difficulties appear to be minor.

2. This paper reports on some key sensitivities in the new version of the model, and how these sensitivities differ from the old version (the model using the revised macro sector and the old energy sector). Five relationships are examined.

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- 1) The short- and medium-term OECD price elasticity of demand for energy.
- 2) The short- and medium-term price elasticity of demand for OPEC oil exports.
- 3) The response of OECD energy prices to OPEC oil price changes.
- 4) The response of OECD economic activity to changes in energy prices.
- 5) The response of world oil prices to a change in OPEC supply.

OECD Price Elasticity of Demand

3. The overall price elasticity of demand for energy in the OECD was estimated by using the following procedure. A baseline estimate was established using a constant nominal oil price of \$30 per barrel, 1982 to 1987. In an alternative scenario the price of oil was cut to \$25 for the entire period. Real GNP was forced to remain constant in each of the OECD countries by adjusting nominal government consumption appropriately.

4. In the new version of the model a drop in OPEC oil nominal export prices of 17 percent translates into a drop in OECD average end-use energy prices in real terms of about 7

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percent in the first year, and into a rise in primary energy demand of 0.95 percent. The estimated price elasticity of demand is -0.13 in the first year and -0.50 after six years. These estimates are about twice as high in the first two years and about 25 percent higher by the sixth year than those from the old version of the model.

Table 1

New Version Model:
Cuts in OECD Energy Demand Caused by a 17 Percent Cut
in OPEC Export Prices
(Real OECD GNP Held Constant)

| Year | <u>Price Elasticity Estimates*</u> | | | | |
|------|--|--|---|-----------------------------|---------------------------|
| | OECD Primary Energy Demand Percent Change | OECD Final Energy Demand Percent Change | OECD Real Energy Prices Percent Change | Primary Energy Demand | Final Energy Demand |
| 1982 | +0.95 | +1.19 | -7.1 | -.13 | -.17 |
| 1983 | +1.83 | +2.19 | -7.1 | -.26 | -.31 |
| 1984 | +2.34 | +2.68 | -6.6 | -.36 | -.41 |
| 1985 | +2.69 | +3.00 | -6.3 | -.43 | -.48 |
| 1986 | +2.92 | +3.19 | -6.1 | -.48 | -.52 |
| 1987 | +2.97 | +3.19 | -5.9 | -.50 | -.54 |

* "Elasticity" is here defined as the percent change in demand divided by the percent change in real price. The real price is defined as the energy price index divided by the GNP deflator.

5. In the old version of the model, total OECD primary energy demand is not readily ascertainable, thus only the results for final energy demand are shown.

Table 2

Old Version Model:
Cuts in OECD Energy Demand Caused by
A 17 Percent Cut in Nominal OPEC Export Prices
(Real OECD GNP Held Constant)

| Year | OECD Final Energy Demand (Percent Change) | OECD Real Energy Prices (Percent Change) | Price Elasticity Final Energy Demand |
|------|---|--|---|
| 1982 | +0.39 | -7.0 | -0.06 |
| 1983 | +1.02 | -7.1 | -0.14 |
| 1984 | +1.72 | -6.8 | -0.25 |
| 1985 | +2.33 | -6.5 | -0.36 |
| 1986 | +2.68 | -6.3 | -0.42 |
| 1987 | +2.59 | -5.9 | -0.44 |

6. In the new version of the model, the elasticities show considerable variation among the OECD countries with France and Italy below (in absolute terms) - 0.1 in the first year, and the United Kingdom, Germany, and Canada above -0.3. After six years the elasticity estimates show much less dispersion.

OPEC Oil Exports: Estimated Price Responsiveness

7. In both versions of the model, a decrease in oil prices leads to a decrease in world energy prices, an increase in world energy demand, and an increase in OPEC oil exports. The higher price elasticity of demand in the new version of the model results in a higher estimate of the increase in OPEC export volume for a given price decrease.

Table 3

Estimated Increase in OPEC Oil Exports
For a 17 Percent Cut in
Nominal Oil Prices, 1982-1987

| <u>New Version</u> | | <u>Old Version</u> | |
|--|--|--|--|
| Percent Change in OPEC Export Volume | Implied Price Elasticity of Demand for OPEC Exports | Percent Change in OPEC Export Volume | Implied Price Elasticity of Demand for OPEC Exports |
| 1982 | +4.38 | -0.30 | -0.13 |
| 1983 | +6.74 | -0.48 | -0.23 |
| 1984 | +7.20 | -0.55 | -0.33 |
| 1985 | +7.35 | -0.59 | -0.41 |
| 1986 | +7.32 | -0.62 | -0.46 |
| 1987 | +6.88 | -0.60 | -0.46 |

* Elasticity is here defined as the percent change in Export volume divided by the percent change in real oil prices. The real oil price is defined as the nominal oil price index divided by the aggregate OECD GNP deflator.

The Responsiveness of Average Energy Prices in the OECD Countries to Changes in OPEC Export Prices

8. The estimated size and speed of the passthrough of world oil price changes to domestic energy prices is a key relationship in the model. If the passthrough is large and speedy, an OPEC price cut will bring a country's average energy price down more, stimulating more GNP growth, more energy demand, and lower inflation. The estimates of the passthrough in the new version differ only slightly from those of the old version. The passthrough varies widely among the OECD countries, with the United States exhibiting the largest first-year passthrough, and Canada the smallest.

Table 4

Estimated Change in Average End-Use
Energy Prices in Response to a
Cut in OPEC Oil Export Prices

| | | <u>New Version</u> | <u>Old Version</u> |
|------|---|--|--|
| | Percent Change In OPEC Oil Export Price | Percent Change In Average OECD Energy Prices | Percent Change In Average OECD Energy Prices |
| 1982 | -16.7 | -7.9 | -7.4 |
| 1983 | -16.7 | -8.4 | -8.1 |
| 1984 | -16.7 | -8.2 | -8.0 |
| 1985 | -16.7 | -8.0 | -7.9 |
| 1986 | -16.7 | -7.9 | -7.6 |
| 1987 | -16.7 | -7.7 | -7.3 |

Table 5

Estimated Change in Average End-Use
Energy Prices in Response to a Cut in OPEC
Oil Export Prices - New Version Model

| | Percent Change In OPEC Export Prices | <u>Percent Change in End-Use Energy Prices</u> | | | | | | |
|------|--|--|-------|---------|--------|------|-------|--------|
| | | US | Japan | Germany | France | UK | Italy | Canada |
| 1982 | -16.7 | -9.3 | -8.7 | -4.2 | -6.4 | -4.0 | -9.2 | -1.5 |
| 1983 | -16.7 | -9.9 | -8.9 | -5.7 | -6.4 | -5.2 | -9.7 | -1.7 |
| 1984 | -16.7 | -9.8 | -8.1 | -5.7 | -6.0 | -5.0 | -9.8 | -1.7 |
| 1985 | -16.7 | -9.6 | -7.5 | -5.6 | -5.8 | -4.7 | -10.0 | -1.7 |
| 1986 | -16.7 | -9.4 | -7.0 | -5.5 | -5.5 | -4.3 | -10.2 | -1.8 |
| 1987 | -16.7 | -9.2 | -6.5 | -5.5 | -5.0 | -3.8 | -10.4 | -1.7 |

The Estimated Response of OECD Economic Growth to Changes in OPEC Prices

9. In another set of simulations, OECD GNP was allowed to vary in response to a fall in oil prices. The altered energy demand elasticities in the new version of the model affect the estimates of the change in OECD GNP in response to oil-price cuts only slightly. *

Table 6

Estimated Change in OECD Real GNP
Due to a Cut in OPEC Export Prices
From \$30 to \$25 a Barrel
(Percent Change)

| | New Version | Old Version |
|------|-------------|-------------|
| 1982 | +0.56 | |
| 1983 | +0.92 | +0.57 |
| 1984 | +1.14 | +0.91 |
| 1985 | +1.22 | +1.09 |
| 1986 | +1.23 | +1.16 |
| 1987 | +1.24 | +1.18 |
| | | +1.19 |

Table 7

Estimated Change in OECD Real GNP Due to a
Cut in OPEC Export Prices From \$30 to \$20 a Barrel
(Percent Change)

| | New Version | Old Version |
|------|-------------|-------------|
| 1982 | +1.18 | |
| 1983 | +1.96 | +1.18 |
| 1984 | +2.43 | +1.91 |
| 1985 | +2.59 | +2.31 |
| 1986 | +2.62 | +2.44 |
| 1987 | +2.60 | +2.48 |
| | | +2.48 |

* In these growth scenarios key government policy variables such as nominal government expenditure, the discount rate, and the nominal money supply were not changed from the baseline assumptions.

The higher elasticities in the new version of the model mean that exogenous cuts in the oil price will result in much larger increases in demand for OPEC oil. In the old version of the model, a fall in the price of oil from \$30 to \$20 led to a rise in OPEC export volume of 1.1 million barrels per day, in the first year. In the new version, the first-year increase is 2.2 mbd. After six years, the estimates are closer together, 4.5 mbd for the old version vs. 5.6 mbd for the new version.

Table 8

Estimated Increase in OPEC Oil Exports Given a Cut in
Oil Prices From \$30 to \$20 per Barrel
(OECD Real GNP Not Held Constant)

| | <u>New Version</u> | | <u>Old Version</u> | |
|------|--------------------|----------|--------------------|----------|
| 1982 | +2.2 | (+12.9%) | +1.1 | (+6.6%) |
| 1983 | +3.6 | (+20.5%) | +2.1 | (+11.4%) |
| 1984 | +4.4 | (+22.7%) | +3.0 | (+14.9%) |
| 1985 | +5.0 | (+23.1%) | +3.7 | (+17.3%) |
| 1986 | +5.4 | (+22.7%) | +4.3 | (+18.6%) |
| 1987 | +5.6 | (+21.3%) | +4.5 | (+18.3%) |

The Estimated Response of World Oil Prices to a Change in OPEC Supply

10. The simulation results reported above all use an assumed price for OPEC oil and solve the model for world demand for OPEC oil. OPEC is assumed to provide enough export volume to meet the demand. The model can also be used to estimate the oil price which equilibrates the market at any given level of OPEC oil export volume.

11. To test the sensitivity of the new version, OPEC export volume was assumed to fall one million barrels per day below the level estimated with oil priced at \$30 per barrel. The new version of the model estimates that the price of oil would rise 18 percent in the first year of the supply cut-off, compared to a 36 percent estimate in the old version of the model.

Table 9

Estimated Increases in World Oil Prices
Associated With a One Million Barrel Per Day
Cut in OPEC Export Volume

| | Baseline Price Assumption (dollars per barrel) | Baseline OPEC Export Volume Estimate (million barrels per day) | Estimated Price | | | |
|------|---|---|---|----------|--------------------|----------|
| | | | <u>With One MBD Less OPEC Exports</u> (dollars per barrel) | | | |
| | | | <u>New Version</u> | | <u>Old Version</u> | |
| 1982 | \$30.00 | 17.2 | 35.38 | (+17.9%) | 40.91 | (+36.3%) |
| 1983 | 30.00 | 17.7 | 32.52 | (+8.4%) | 32.93 | (+9.8%) |
| 1984 | 30.00 | 19.4 | 32.26 | (+7.5%) | 31.22 | (+4.1%) |
| 1985 | 30.00 | 21.7 | 32.06 | (+6.9%) | 31.70 | (+5.7%) |
| 1986 | 30.00 | 23.9 | 32.01 | (+6.7%) | 32.36 | (+7.9%) |
| 1987 | 30.00 | 26.5 | 32.16 | (+7.2%) | 33.47 | (+11.6%) |

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